CHAPTER 5
DEMAND FOR REMEDIATION OF UNDERGROUND STORAGE TANK SITES

Millions of underground storage tanks (USTs) containing petroleum products or hazardous chemicals are located throughout the United States. USTs are used by a wide variety of industries, such as petroleum and chemical manufacturing and distribution, transportation, agriculture, and government. About 1.1 million active tanks are currently subject to federal regulations, and about 96 percent of these contain petroleum products, including used oil. Less than 1 percent contain hazardous materials and 2 percent are empty. In addition, about one million federally regulated USTs have been closed.

Releases of petroleum or hazardous substances can result from a spill during tank filling operations, leaks in the tank or pipes attached to the tank due to corrosion, structural failure, or faulty installation. As of September 1996 almost 318,000 releases at federally regulated USTs had been confirmed, and more are expected. These releases can contaminate soil and groundwater and cause fires or explosions.

Subtitle I of the Hazardous and Solid Waste Amendments to the Resource Conservation and Recovery Act (RCRA), was enacted in 1984 to control and prevent leaks and spills from USTs. Subtitle I governs USTs storing regulated substances, including gasoline, aviation fuel, diesel fuel, other petroleum products, and hazardous substances defined under the Superfund program. Pursuant to Subtitle I, EPA has promulgated regulations requiring, among other things, that leaks and spills be detected and reported, contamination caused by leaks and spills be remediated, future releases be prevented, and each state has a regulatory program for USTs that is at least as stringent as that under the federal regulations. These regulations have compelled cleanup activities at many UST sites, providing opportunities for the application of a variety of remedial technologies.

5.1 Program Description

The federal regulatory program is implemented by EPA's Office of Underground Storage Tanks (OUST). The federal UST technical requirements and state program approval regulations were promulgated in September 1988, and became effective on December 22, 1988.[1] These regulations, to a large extent, determine the size of the market for cleanup services.

The regulations apply to any UST, except those specifically exempted, used to store petroleum products or substances defined as hazardous under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The regulations do not apply to tanks storing hazardous wastes regulated under Subtitle C of RCRA. An UST is defined as any tank that has at least 10 percent of its volume buried below ground, including piping connected to the tank. Generally, the requirements for tanks containing chemicals are somewhat more stringent than those containing petroleum products.

The basic federal requirements include:

- A tank owner must register his or her tank(s) with the state authority by completing a notification form about the characteristics and contents of the UST.
- A tank owner must institute a periodic leak detection program to actively seek out releases. For tanks installed after December 1988, leak detection requirements become effective at the time of installation. For older tanks, the requirements were phased in over time with a final completion date in December 1993.
- A tank owner must maintain records of leak detection activities, corrosion protection

system inspections, repair and maintenance activities, and post-closure site assessments.

- A tank owner must notify the appropriate regulatory authority of all suspected or confirmed releases as well as follow-up actions taken or planned. Suspected leaks must be investigated immediately to determine if they are real. If evidence of environmental damage is the cause for suspicion, it must be reported immediately to the regulatory authority.

- If a leak or spill is confirmed, tank owners must: (a) take immediate action to stop and contain the leak or spill; (b) notify the regulatory authority within 24 hours or other reasonable time periods specified by the implementing agency; and (c) take action to mitigate further damage to people and the environment.

- By December 1998, all USTs must have corrosion protection and devices that prevent spills and overfills.

- A tank owner also has the option of closing USTs, but must notify the regulatory authority 30 days before permanent closure.

In addition to providing performance standards, the regulations establish requirements that a state must meet to receive EPA approval for its program. State or local authorities may have requirements that are somewhat different or more stringent. All states and territories have passed legislation for UST cleanups, and 45 states have state trust funds. The following kinds of tanks are currently *exempt* from the regulations:

- Farm and residential tanks holding 1,100 gallons or less of motor fuel used for non-commercial purposes;
- Tanks storing heating oil used on the premises where it is stored;
- Storage tanks on or above the floor of areas such as basements or tunnels;
- Septic tanks and systems for collecting storm water and wastewater;
- Flow-through process tanks;
- Tanks holding 110 gallons or less; and
- Emergency spill and overfill tanks.

Changes in the types of tanks covered by the regulations could significantly impact the potential size of the market. However, EPA is not contemplating any such changes at this time.

5.2 Factors Affecting Demand for Cleanup

The demand for remediation services at contaminated UST sites primarily will be influenced by federal regulations, state requirements, and the number of releases occurring at old and new tanks. Specifically, the following factors affect this market:

- The implementation of leak detection requirements (which became effective in 1993), in combination with the reporting requirements, have led to a large number of confirmed releases.

- The implementation of tank upgrading requirements, which become effective in 1998, is expected to cause an increase in the reporting of releases.

- Over a longer period of time, after 1998, it is anticipated that the rate of occurrence of confirmed releases will decline, because the failure rate of tanks will eventually decrease as a result of improved tank systems.

- Some states have promulgated requirements that are more stringent than the federal standards, such as a requirement for double-lined tanks, more stringent monitoring procedures, or earlier upgrading compliance dates.

- The pace of the cleanups will be affected by the adequacy of the reimbursement funds used by 45 states to help pay for needed cleanups. Most of the cost of UST cleanups by responsible parties (RPs) in these states are now paid out of these funds, and some of them often do not have sufficient money to clean up all of the eligible sites in a given year. The Federal Trust Fund accounts for a smaller portion of expenditures on UST cleanups than the state funds. These funds may be used for the oversight of RP cleanups and direct state cleanups where the RPs are insolvent, recalcitrant, or cannot be identified or located.

- The failure rate of tank systems is determined by such factors as tank age, material of construction, corrosion protection systems in place, and other design and site-specific factors such as soil type and weather. Because information on these factors is limited, estimates of market size are subject to some uncertainty. The estimates in the following section are based on the current RCRA requirements and available data.

- The availability of credit to UST owners, especially the many small businesses that operate USTs, is necessary to assist them in meeting their obligations to upgrade, maintain, and otherwise comply with RCRA Subtitle I and related environmental requirements. In September 1995, EPA promulgated regulations to encourage the extension of credit to credit-worthy UST owners. These regulations exempt from the definition of UST "owner" for purposes of corrective action persons who maintain an indicia of ownership in an UST or UST system primarily to protect a security interest, but are not otherwise engaged in petroleum production, refining, and marketing. Thus, any person or lending institution that guarantees loans secured by real estate containing an UST or UST system may not be liable for the required corrective action.[2]

5.3 Number and Characteristics of Sites

The data on the number and status of currently registered USTs are derived from data that EPA compiled from reports it periodically receives from 56 states and territories. States compile their data from information received from tank owners. The information in this chapter on the size, contents, construction materials, and other characteristics of USTs are derived from a survey EPA conducted in 1991.[3] Although this source is the most complete nationwide compilation of tank characteristics, the types and characteristics of the tank population has probably changed since it was conducted. Since then, over 600,000 tanks have been closed and newer tanks tend to be larger than older tanks. Thus, these data should be considered as an approximation of the distribution of the tank population.

Reporting quality varies among the states and has resulted in some under-reporting of the number of tanks subject to the regulations. Estimates of the extent of under-counting range from 15 percent to 80 percent.[a] However, since conditions probably have changed in the six years since these estimates were compiled, these factors are not included in the estimates provided here.

EPA reports most of these data in terms of the numbers of tanks. However, for purposes of this study, the data also are converted to "number of UST sites." EPA estimates that there is an average of 2.7 tanks per UST site, although the number actually varies widely among the sites.

5.3.1 Number of USTs

The number of potential corrective actions are related to the population of active and closed tanks subject to the federal regulations. EPA reports that as of September 30, 1996, 1,064,478 active tanks and 1,074,022 closed tanks have been registered in the U.S.[4] Using EPA's estimated average of the 2.7 tanks per site, approximately 792,037 sites with USTs are subject to the UST corrective action regulations. Estimates of the percentage of sites that are likely to leak and require cleanup of contaminated soils or groundwater are presented later in this section.

In 1988, EPA estimated that there were between 5 and 7 million USTs.[1] Taking the midpoint of this range implies a total UST population of 6.0 million, of which 2.1 million active and closed USTs are currently subject to the regulations. The remaining 3.9 million tanks are exempt from the federal regulations and not included as part of the market for remediation services in this report. Section 5.1 identifies the seven exempt categories of tanks. Although the exempt tanks are not considered part of the market in this report, they,

[a] Bueckman, Donna S., S. Kumar, and M. Russell, *Underground Storage Tanks: Resource Requirements For Corrective Action*, pages 17-19 and 31, Waste Management Research and Education Institute, University of Tennessee, December 1991 reports this range based on a review of several surveys. Based on this review, the authors estimated the average under-counting for the country to be 35%.

nevertheless, represent a potential for cleanup work in selected states where state regulations include some exempt tanks.

The following sections describe some basic characteristics of the federally regulated sites, such as their contents, ownership, size, and age. These descriptions are based on data collected by EPA in 1991, which is the most comprehensive source for this type of data identified. Although some characteristics of the tank population, such as average tank size, probably have changed since 1991, these data are the only national source available.

5.3.2 Types of Contaminants Found at UST Sites

The substances stored in RCRA-regulated tanks in 1991 are depicted in Exhibit 5-1. Most USTs contain petroleum products, which are mixtures of four types of hydrocarbons: paraffins, olefins, napthalenes, and aromatics. The literature contains data on the concentrations of benzene, toluene, ethylbenzene, and xylene (BTEX) in gasoline and diesel fuel, but information on the concentration of these constituents in other petroleum products is more limited. BTEX compounds also have been detected in soil and other media at UST sites where gasoline is stored.[5]

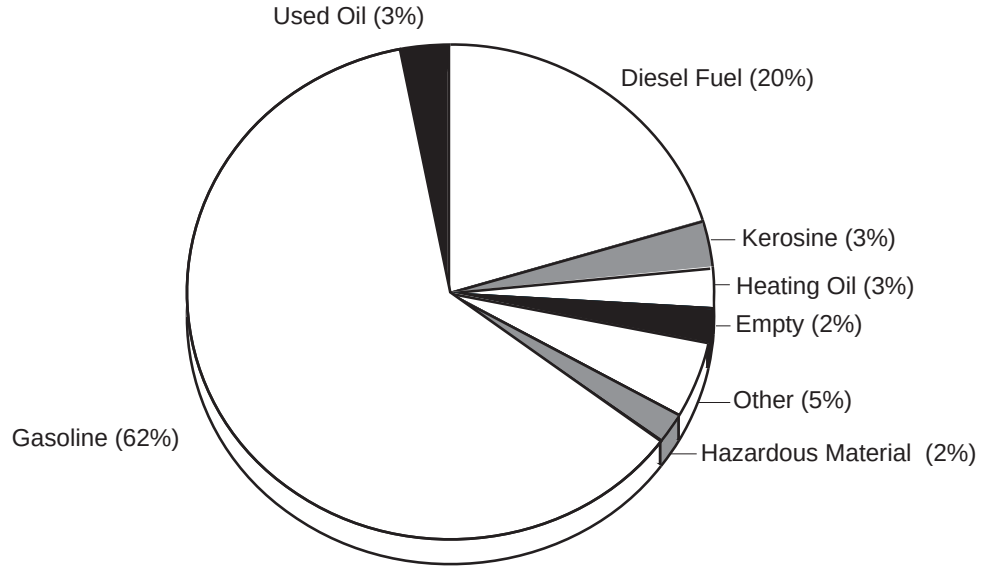
5.3.3 Ownership of Tanks

In 1991, private companies and individuals owned 69 percent of the tanks, state and local governments owned 8.4 percent, and the federal government and Indian tribes owned 2.2 percent. The ownership of the remaining 20.4 percent has not been identified.

5.3.4 Size and Age of Tanks

The size and age of a tank may contribute to the extent of the contamination and to the type of work needed at a site. Exhibit 5-2 shows the number of tanks of different sizes reported in the EPA survey, as of Spring 1991. Almost two-thirds of the tanks were between 2,000 and 30,000 gallons, and 28 percent were between 100 and 2,000 gallons. However, the size distribution may have changed somewhat over the past five years because newer facilities tend to have larger tanks, on average, than older facilities, and the tanks that have closed are primarily older.

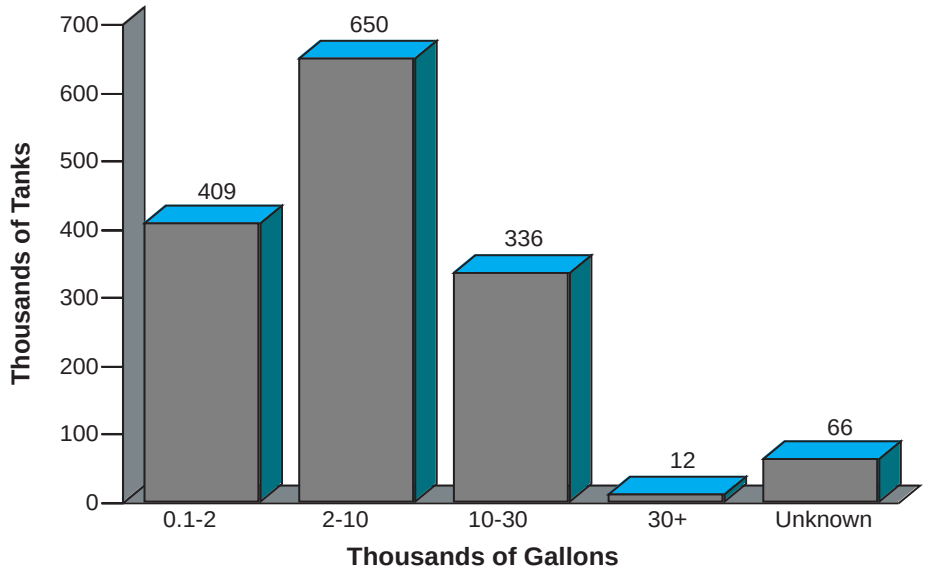
Exhibit 5-1: Contents of Federally Regulated Active and Closed Tanks as of Spring 1991



Notes: Based on a survey involving 1.6 million active and closed tanks in the spring of 1991. The distribution of USTs probably has changed somewhat, since approximately 600,000 tanks have closed since 1991.

Source: U.S. EPA, Office of Underground Storage Tanks, *National Survey of Underground Storage Tanks*, Spring 1991.

Exhibit 5-2: Size of Federally Regulated Tanks as of Spring 1991



Note: Based on data on 1.5 million active and closed tanks in Spring 1991. The size distribution of USTs probably has changed because approximately 600,000 tanks have closed since 1991 and the newer facilities tend to have larger tanks.

Source: U.S. EPA, Office of Underground Storage Tanks, *National Survey of Underground Storage Tanks*, Spring 1991.

Exhibit 5-3 shows the age of federally regulated tanks, including closed tanks. The probability of a leak is directly related to tank age. In 1991, 28 percent of the regulated tanks were over 25 years old. Data are not available on the current distribution of tank age.

5.3.5 Location of Regulated Tanks

Appendix B lists the number of regulated tank sites by state, as reported in September 1996. California, Texas, New York, Florida, North Carolina, Michigan, and Pennsylvania contain almost 40 percent of all active and closed tanks. The location data should be used with caution because the number of tanks in a state may not be correlated with the number of releases, and reporting quality varies among the states.

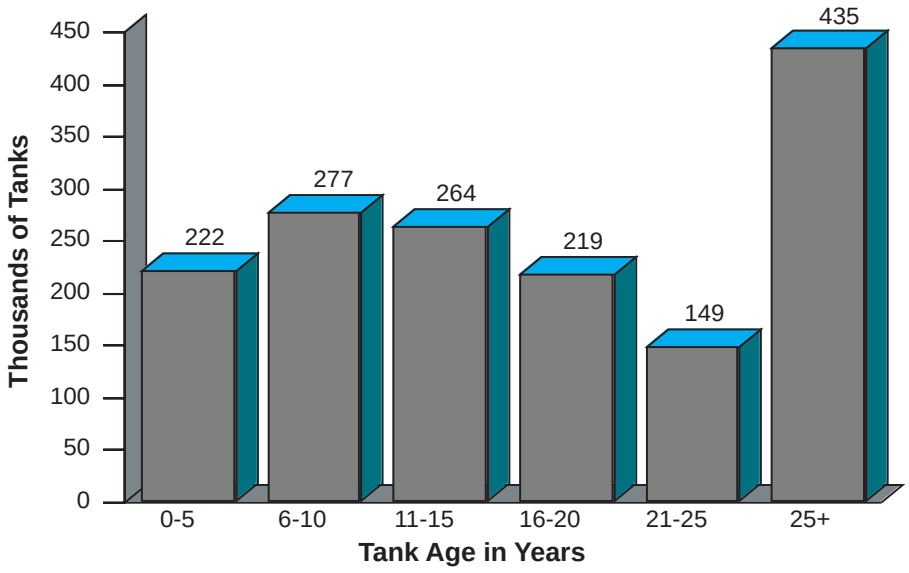
5.3.6 Potential Number of Sites to be Cleaned Up

EPA has estimated that the number of confirmed releases ultimately will total at least 418,000.[b] By September 1996, almost 318,000 of these releases had already been reported to EPA, and remedial design or remedial action had been initiated at almost 253,000 of these sites. Thus, it is estimated that 165,000 UST sites will ultimately need remediation (Exhibit 5-4).

Although the size of the entire market has been estimated, the year-to-year fluctuations in cleanup efforts are difficult to predict. EPA estimates that the RCRA UST requirements probably will cause an increase in the number of releases reported, followed by a decrease. The increase will result from the phase-in of tank upgrading requirements in 1998. The decline in confirmed releases will result from improvements in the types of tank systems and leak detection and monitoring practices required by RCRA. Exhibit 5-5 shows the corrective action activity for the past six years. The difference between confirmed releases and cleanups initiated has averaged over 64,000 for the past four years.

[b] Although the number of confirmed releases may not precisely equal the number of sites with releases, EPA estimates that the difference is small. Therefore, for the purpose of this analysis it is assumed that the number of confirmed releases equals the number of sites with releases.

Exhibit 5-3: Age of Federally Regulated Tanks as of Spring 1991



Note: Based on a survey of 1.6 million active and closed tanks in Spring 1991. The 600,000 tanks that have closed since 1991 tend to be older tanks. The age distribution probably has changed somewhat.

Source: U.S. EPA, Office of Underground Storage Tanks, *National Survey of Underground Storage Tanks*, Spring 1991.

5.3.7 Quantities of Contaminated Material

The volume of soil to be cleaned up varies widely from one site to another. A 1990 EPA survey provided data from 16 states on the average volume of soil and debris excavated at UST sites. The median volume for the 16 states ranged from 9 to 800 cubic yards, with a weighted average of 190. Multiplying this average by the number of sites expected to need remediation (165,000) results in an estimated 31.4 million cubic yards of material needing remediation. No information is available on the quantities of groundwater and surface water needing remediation.

5.4 Estimated Cleanup Costs

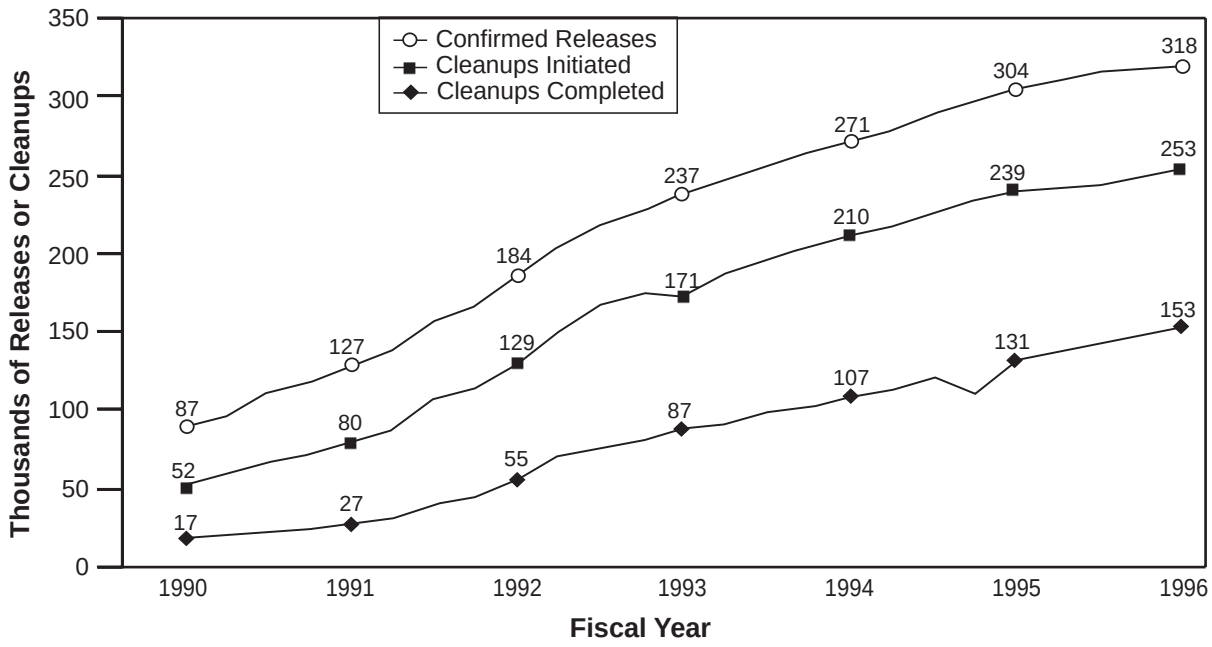
Based on a review of literature and data, the University of Tennessee reported that the cost of remediating UST sites had varied widely, generally between $2,000 to over $400,000. Costs at individual sites can exceed a million dollars.[6] Based on experience with a limited number of projects, EPA estimates that the average remediation cost per site is $125,000. This cost estimate includes treatment or disposal of soil and groundwater, site investigations, and feasibility studies. It does not include costs related to excavating, disposing of, or repairing tanks and related

Exhibit 5-4: Estimated Number of UST Sites Requiring Cleanup

	Reported to EPA	Sites with Future Releases	Total
Confirmed Releases	318,000	100,000	418,000
Cleanups Initiated[a]	253,000	0	253,000
Future Cleanups Required[b]	65,000	100,000	165,000

Notes:
[a] Some of these sites may not yet have designated cleanup contractors, but how many is not known.
[b] "Future Cleanups Required" is derived by subtracting "Cleanups Initiated" from "Confirmed Releases."

Exhibit 5-5: Status of UST Corrective Actions (Cumulative)



Source: U.S. EPA, Office of Underground Storage Tanks, Quarterly Reports, September 1990-September 1996; and Semiannual Reports, March 1996 and September 1996.

equipment such as piping. Multiplying this average by the number of sites expected to need remediation, the projected total remediation cost is $20.6 billion.

As discussed previously, EPA anticipates that cleanup activities will increase as the December 1998 deadline for upgrading tanks for corrosion protection and spill and overfill prevention approaches, and then decrease.

5.5 Market Entry Considerations

The following factors will be important to the success of vendors operating in the UST remediation market.

- Site work is primarily the responsibility of tank owners, especially of establishments such as retail gasoline stations, petroleum and chemical marketers, and fleet maintenance, auto repair, manufacturing, or transportation facilities.

- The level of enforcement activity varies from one state to another. In addition, some states regulate tanks that are not regulated under RCRA. Information on these activities generally are available through state authorities.

- As tank testing and other requirements are implemented, the extent of cleanup activities and costs per site probably will decrease. Thus, economical ways to remediate smaller releases may be needed.

5.6 Remedial Technologies

Data on the kinds of innovative technologies used to remediate contaminated UST sites have not been centralized. A study conducted in 1995 by EPA and the University of Massachusetts provided information on trends in the frequency of selection of alternative technologies as well as the kinds of technologies being used for cleanups.[7] The study was based on information collected from 49 state LUST program offices who responded to a written survey. Respondents were asked to provide reasonable estimates to survey questions, not to conduct file searches or research before responding. Thus, the results, which were

based on the responses received, should be considered approximations.

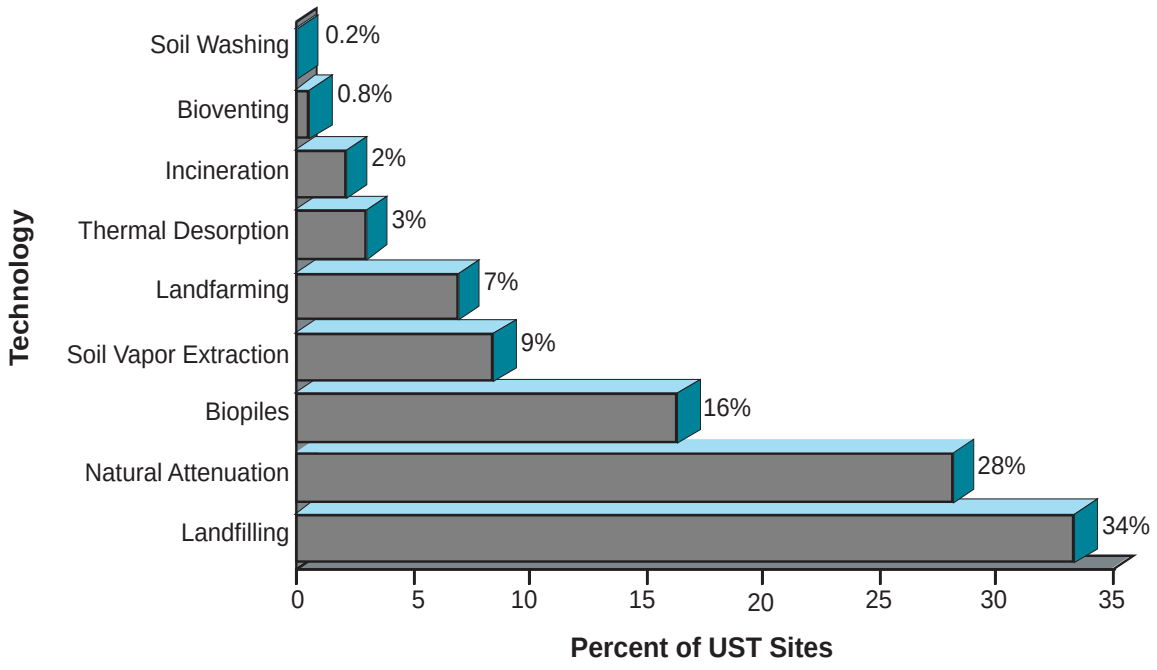
Based on the responses of the 49 states in 1995, approximately 96,000 sites were undergoing remediation in these states, or an average of almost 2,000 sites per state. Exhibit 5-6 shows the percentage of sites at which soil remediation technologies were being used. Landfilling was the most frequently selected option for soil remediation, followed by natural attenuation, biopiles, and soil vapor extraction.

Exhibit 5-7 shows the percentage of sites in 1995 at which groundwater technologies were being used. Natural attenuation and pump-and-treat were the most frequently selected groundwater technologies, at 47 percent and 29 percent of the sites, respectively.

Although most of these percentages appear low, they represent substantial increases in the relative use of these technologies. According to state and federal regulators, the use of air sparging has grown from only a handful of sites four years prior to the study to about 13 percent of the 35,000 sites undergoing groundwater remediation in 1995. According to thermal desorption industry representatives, thermal desorption was used on a limited basis four years prior to the study, and in 1995 was used at numerous sites in almost every state.[7] The 1995 EPA study indicated that thermal desorption was selected for about 3.1 percent of the sites undergoing soil remediation in 1995. The study also indicated that the use of all alternative technologies has increased during the two years before the study. Exhibit 5-8 shows the percentage of state LUST program offices that had noted increases in technologies between 1993 and 1995.

The use of on-site technologies had increased and the use of off-site technologies had decreased from 1993 to 1995 (Exhibit 5-9). Most of the increases were accounted for by the use of natural attenuation, soil vapor extraction, bioventing, air sparging, *in situ* bioremediation, and dual-phase extraction. For the study, off-site technologies included landfilling, incineration, thermal desorption, biopiles, and landfarming. All other technologies were considered on-site. (Since the study, some of the traditional off-site

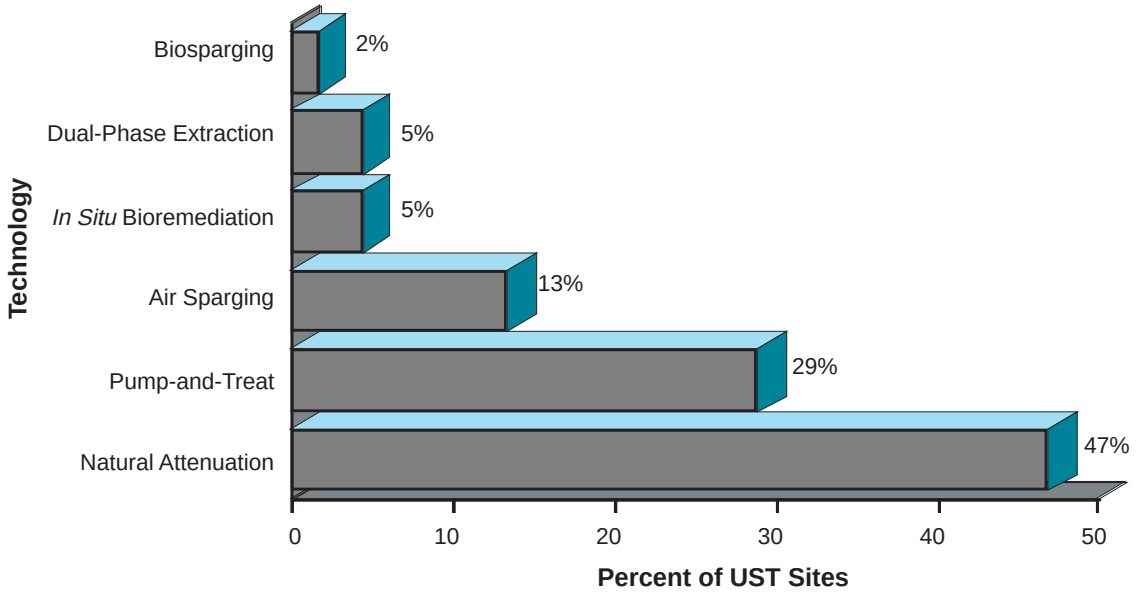
Exhibit 5-6: Percentage of UST Sites Using Specific Soil Remediation Technologies



Note: Based on information covering 103,000 sites.

Source: Tremblay, Deborah, L., D. S. Tulis, P. Kostecki, and Ewald, "Innovation Skyrockets at 50,000 LUST Sites," *Soil and Groundwater Cleanup*, December 1995.

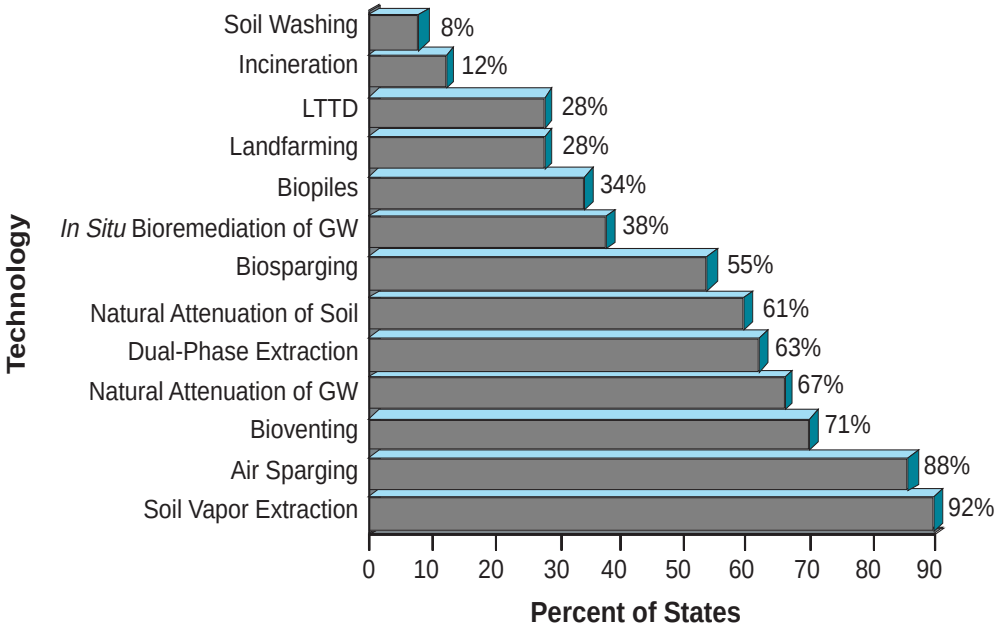
Exhibit 5-7: Percentage of UST Sites Using Specific Groundwater Remediation Technologies



Note: Based on information covering 36,000 sites. Percentages do not add to 100% due to rounding.

Source: Tremblay, Deborah, L., D. S. Tulis, P. Kostecki, and Ewald, "Innovation Skyrockets at 50,000 LUST Sites," *Soil and Groundwater Cleanup*, December 1995.

Exhibit 5-8: Percentage of States Reporting Increased Use of Alternative Technologies



Note: GW = groundwater; LTTD = low temperature thermal desorption.

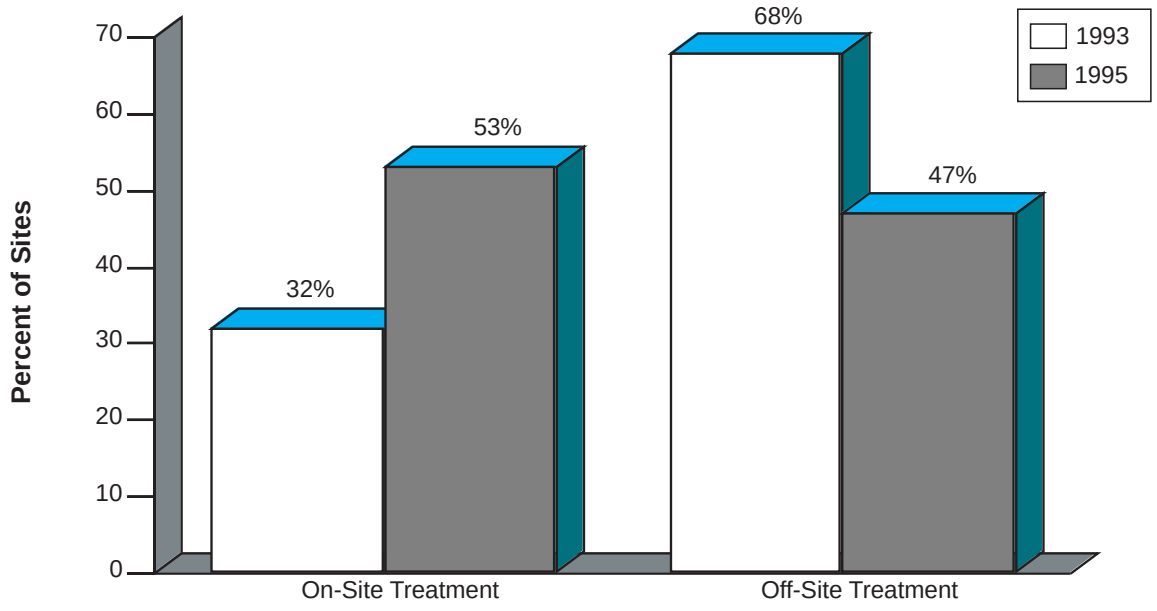
Source: Tremblay, Deborah, L., D. S. Tulis, P. Kostecki, and Ewald, "Innovation Skyrockets at 50,000 LUST Sites," *Soil and Groundwater Cleanup*, December 1995.

technologies are now being conducted on-site [*e.g.*, biopiles and LTTD]).

The use of innovative and other alternative technologies may help accelerate the pace of, or reduce the cost of, remediating UST sites. Nevertheless, according to a more limited EPA study conducted in 1992, most site cleanups tended to involve more traditional approaches.[8] The use of innovative technologies often was hampered by a lack of cost or performance data, a lack of expertise among state and contractor personnel, and the need for additional permit requirements. To help overcome these barriers, EPA conducted demonstration projects and provided guidance, training, and workshops at UST sites. Technologies addressed in these efforts included soil vapor extraction, air sparging, enhanced bioremediation, and low-level thermal desorption. In recent years, EPA has made available reference materials and training programs to assist site managers, vendors, and others in these areas. These materials are listed in Section 5.7. [9][10][11][12][13][14][15]

The 1995 study found that data on technology performance and the availability of trained consultants and regulators had improved over the previous two years. The primary obstacles to the selection of alternative technologies have shifted from a lack of available information and trained personnel to the potentially high costs, long cleanup times, and lack of confidence in the technologies.

Exhibit 5-9: Changes in the Use of On-Site and Off-Site Treatment



Source: Tremblay, Deborah, L., D.S. Tulis, P. Kostecki, and K. Ewald, "Innovation Skyrockets at 50,000 LUST Sites," *Soil and Groundwater Cleanup*, December 1995.

5.7 References

1. U.S. Environmental Protection Agency, Office of Underground Storage Tanks, "Technical Requirements and State Program Approval; Final Rule," 53 *Federal Register*, No. 185, September 23, 1988.

2. U.S. Environmental Protection Agency, "Underground Storage Tanks — Lender Liability; Final Rule," 40 CFR Parts 280 and 281," *Federal Register*, Vol 60, September 7, 1995, p. 46692.

3. U.S. Environmental Protection Agency, Office of Underground Storage Tanks, *Survey of Underground Storage Tanks,* Spring 1991.

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5. U.S. Environmental Protection Agency, Office of Underground Storage Tanks, *TC [Toxicity Characteristic] Study of Contaminated Media and Debris,* Draft, July 1992.

6. Bueckman, D.S., S. Kumar, and M. Russell, *Underground Storage Tanks: Resource Requirements for Corrective Action*, University of Tennessee, Waste Management Research and Education Institute, Knoxville, TN, December 1991.

7. Tremblay, Deborah, L., D. S. Tulis, P. Kostecki, and K. Ewald, "Innovation Skyrockets at 50,000 LUST Sites," *Soil and Groundwater Cleanup,* December 1995.

8. U.S. Environmental Protection Agency, Office of Underground Storage Tanks, and Technology Innovation Office *Technologies and Options for UST Corrective Actions: Overview and Current Practice,* EPA/542/R-92/010, August 1992.

9. U.S. Environmental Protection Agency, Office of Underground Storage Tanks, *How to Evaluate Alternative Cleanup Technologies for UST Sites: A Guide for Corrective Action Plan Reviewers*, EPA-510-B-95-007, May 1995.

10. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Technology Innovation Office, Cleanup Information Bulletin Board System (CLU-IN). CLU-IN may be accessed by: (a) using a modem to dial 301-589-8366; (b) or (b) a World Wide Web connection: *http://www.Clu-in.com*

11. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Office of Underground Storage Tanks, World Wide Web connection: *http://www.epa.gov/OUST.*

12. University of Massachusetts, Contaminated Soils Conferences, University of Massachusetts, N344 Morrill, Amherst, Massachusetts 01003, attention Linda Rosen.

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14. U.S. Environmental Protection Agency, Office of Underground Storage Tanks, *How to Effectively Recover Free Product for LUST Sites: A Guide for State Regulators,* EPA-510-R-96-004, September 1996.

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